**Developing Students' Sustainability Skills in Computer Science via Software System Design**

**Dr Leon Watts & Dr Simon Jones, Department of Computer Science**
**University of Bath**

This example showcases how skills associated with achievement of sustainable development, as identified by the National Union of Students (NUS)[1], are embedded into the compulsory first year undergraduate Computer Science degree module 'Computing as a Science and Engineering Discipline (C-SED)', at the University of Bath.

Following teaching, students are set a piece of written coursework. The purpose of the coursework is communicated as follows:

> "To exercise and demonstrate techniques in problem analysis and software system design in a new topic of significance to Computer Scientists (emerging application domain)."

There are two coursework deliverables, which are clearly communicated to the students and separated by a formative feedback point. A summary is provided below:

**Deliverable 1: Key challenges, Proposed Software System, Initial Specification and Software design**
Your group will first write an essay on an emerging application domain in Computer Science, choosing articles and other information sources on one or both of the following topics:

- Smart Hospitals
- Human Enhancement (also known as Human Augmentation)

The primary purpose of your reading and group discussions are to:

- Understand and explain an emerging domain of software application.
- Explain your group's viewpoint on key technical and societal challenges posed within the domain, supported by evidence from your reading.
- Propose a software system (System X) that would address one or more of these challenges, explaining the positive and negative impacts you believe your system might have.

**Deliverable 2: Final report on System X**
Deliverable 2 is your final group report. It will incorporate a revised version of Deliverable 1, according to the modifications, extensions or deletions you have made via the iterative software process your group has adopted, and the feedback received from your tutors. In particular, it will have extended your high-level design by presenting a low-level design for ONE of the components that is modelled as one of its subsystems. This will include:

- Illustrative scenario and use cases
- A Unified Modelling Language Class Model
- Sequence Diagrams and/or State-machine models to represent dynamic elements of your low-level design

Evidence of incorporation of the following NUS sustainability skills[1] (**bold**) into this learning activity is evident:

- **Considering ethical issues linked to your subject.** Students focus on the ethical considerations, as well as the impact their work will have on the functioning of society, guided by the Association of Computing & Machinery Code of Conduct.

- **Planning for the long term as well as the short term.** When considering one of the emerging application domains, students are required to consider the ongoing use of software systems in these domains, in contrast to one off usage. Students are expected to demonstrate consideration of the design principles that they have encountered in the teaching of the unit, especially visibility, economy, spacing, and symmetry, fully considering system-wide qualities such as maintainability and extensibility.

- **Solving problems by thinking about whole systems - including different connections and interactions**. Students are required to present a written discussion that considers the set of challenges they believe are posed by the emerging area, raising both technical and societal issues, rather than a pure focus on only the software itself.

The nature of this coursework also thoroughly supports Dawe *et al*[2]'s sustainability literate graduate attributes, in particular, 'be able to apply theory to practice', ' be able to ameliorate real life problems through employing holistic as well as reductionist approaches, as appropriate to the issue', and 'be able to understand, critically evaluate and adopt thoughtfully sustainability values'. In addition, the coursework is conducted as a group project thus further allows students to develop Dawe[2]'s 'be able to work collaboratively' competence.

Importantly, depending on the emerging domain explored by the students, their work supports the United Nation's Sustainable Development Goals: Goal 3: Good health and well-being; Goal 12 Responsible consumption and production; and Goal 9: Industry, Innovation and Infrastructure. Of course, the teaching and learning activity in itself supports Goal 4: Quality Education.

**References**


1 National Union of Students 2018, *Sustainability Skills 2017-18,* accessed 23 January 2019, <https://sustainability.nus.org.uk/resources/sustainability-skills-2017-18>

2 Dawe, G., Jucker, R. and Martin, S. (2005) *Sustainable Development in Higher Education: Current Practice and Future Developments.* York: Higher Education Academy.